CLAIMS

What is claimed is:

1. An apparatus for conducting a microfluidic process and analysis, said apparatus comprising:

a first substrate;

at least one elongated separation channel in the first substrate, the separation channel having an inlet end and an outlet end;

a fluidic transport for transport of fluids through the separation channel;

a second substrate; and

at least one thick-film electrode on the second substrate, the thick-film electrode being in fluidic connection with the outlet end of the separation channel.

2. The apparatus of claim 1, wherein the fluidic transport comprises a conductive system in fluidic connection with each end of the separation channel for application of a separation voltage.

3. The apparatus of claim 2, wherein the conductive system comprises electrodes.

4. The apparatus of claim 2, further comprising a high-voltage power supply for application of voltage to the conductive system.

5. The apparatus of claim 1, wherein the fluidic transport comprises electrokinetic fluid transport.

6. The apparatus of claim 1, wherein the fluidic transport comprises at least one method selected from the group consisting of electrical, mechanical, centrifugal, magnetic, pneumatic, pressure-activated, and vacuum-activated fluid transport.

7. The apparatus of claim 1, further comprising at least one reference electrode in fluidic connection with the thick-film electrode.

8. The apparatus of claim 1, wherein the first substrate comprises at least one member selected from the group consisting of fused-silica, silica-based, polymer, plastic and elastomer substrates.

9. The apparatus of claim 1, wherein the second substrate comprises at least one member selected from the group consisting of ceramic, polymeric and plastic substrates.

10. The apparatus of claim 1, further comprising an electrical contact to the thick-film electrode.

11. The apparatus of claim 10, further comprising an analyte analysis system in electrical contact with the electrical contact to the thick-film electrode.

12. The apparatus of claim 1, further comprising an analyte analysis system for analyzing an analyte at the thick-film electrode.

13. The apparatus of claim 12, wherein the analyte analysis system comprises an amperometric detection system.

14. The apparatus of claim 13, wherein the amperometric detection system comprises at least one member selected from the group consisting of fixed potential and potential-step amperometric detection.

15. The apparatus of claim 12, wherein the analyte analysis system comprises at least one member selected from the group consisting of a stripping potentiometry system and a voltammetric detection system.

16. The apparatus of claim 1, wherein the thick-film electrode is a screen-printed electrode.

17. The apparatus of claim 1, wherein the separation channel has an average bore diameter of from about 1 μm to about 300 μm.

18. The apparatus of claim 16, wherein the separation channel has an average bore diameter of from about 20 μm to about 120 μm.

19. The apparatus of claim 1, wherein the thick-film electrode has a thickness of from about 1 μm to about 100 μm.

20. The apparatus of claim 19, wherein the thickness of the thick-film electrode is between about 8 μm and 30 μm.

21. The apparatus of claim 1, wherein the first substrate comprising at least one elongated separation channel is detachable from the second substrate comprising at least one thick-film electrode.

22. The apparatus of claim 21, wherein the first substrate is affixed to the second substrate such that the distance between the thick-film electrode and the outlet end of the separation channel is fixed.

23. The apparatus of claim 22, wherein the distance between the thick-film electrode and the outlet end of the separation channel is from about 1 μm to about 500 μm.

24. The apparatus of claim 23, wherein the distance is between about 50 μm and about 100 μm.

25. The apparatus of claim 1, wherein the thick-film electrode comprises a carbon ink electrode.

26. The apparatus of claim 1, wherein the thick-film electrode comprises a metal conducting coating.

27. The apparatus of claim 1, wherein the thick-film electrode comprises at least one member selected from the group consisting of metals, inorganic dopants, organic dopants, nucleic acids, catalytic surface modifiers, enzymatic surface modifiers, and permselective film coatings.

28. The apparatus of claim 1, further comprising at least one cavity in fluidic connection with the inlet end of the separation channel.

29. The apparatus of claim 28, further comprising a buffer cavity and sample cavity in fluidic connection with the inlet end of the separation channel.

30. The apparatus of claim 28, further comprising a reaction cavity in fluidic connection with the inlet end of the separation channel.

31. The apparatus of claim 28, further comprising a plurality of separation channels with the inlet ends thereof in fluidic connection with the cavity.

32. The apparatus of claim 1, further comprising at least one cavity in fluidic connection with the outlet end of the separation channel.

33. The apparatus of claim 1, comprising a plurality of separation channels and a plurality of thick-film electrodes.

34. The apparatus of claim 1, wherein both the first substrate and the second substrate are substantially planar, and the second substrate is at an angle to the first substrate.

35. The apparatus of claim 34, wherein the second substrate is perpendicular to the first substrate.

36. The apparatus of claim 1, wherein both the first substrate and the second substrate are substantially planar and parallel to each other.

37. The apparatus of claim 36, wherein the second substrate forms a seal for at least a portion of the separation channel of the first substrate.

38. The apparatus of claim 1, wherein the separation channel further comprises separation media.

39. A method for detecting an analyte, comprising the steps of:

introducing the analyte in the inlet end of a microfluidic channel having an inlet end and an outlet end;

transporting the analyte in a fluid solution through the microfluidic channel to the outlet end;

contacting the solution containing the analyte with a thick-film electrode in fluidic connection with the outlet end of the microfluidic channel;

providing electrical contact to the thick-film electrode; and

analyzing the analyte at the thick-film electrode by electrochemical detection.

40. The method of claim 39 further comprising the step of:

providing electrical contact to at least one counter electrode in fluidic contact with the thick-film electrode.

41. The method of claim 39 further comprising the steps of:

providing at least one reactant for the analyte; and

mixing the at least one reactant and the analyte prior to analyzing the analyte at the thick-film electrode by electrochemical detection.

42. The method of claim 39, wherein the microfluidic channel comprises a microfluidic separation channel.

43. The method of claim 39, wherein transporting the analyte in a fluid solution through the microfluidic channel is by electrokinetic fluid transport.

44. The method of claim 39, wherein the electrokinetic fluid transport is capillary electrophoresis.

45. The method of claim 39, wherein transporting the analyte in a fluid solution through the microfluidic channel comprises at least one method selected from the group consisting of electrical, mechanical, centrifugal, magnetic, pneumatic, pressure-activated, and vacuum-activated fluid transport.

46. The method of claim 39, wherein analyzing the analyte at the thick-film electrode by electrochemical detection comprises amperometric detection.

47. The method of claim 46, wherein the amperometric detection comprises at least one member selected from the group consisting of fixed potential and potential-step amperometric detection.

48. The method of claim 39, wherein analyzing the analyte at the thick-film electrode by electrochemical detection comprises at least one member selected from the group consisting of stripping potentiometry and voltammetric detection.

49. The method of claim 39, wherein the thick-film electrode is a screen-printed electrode.

50. The method of claim 39, wherein the microfluidic channel has an average bore diameter of from about 1 μm to about 300 μm.

51. The method of claim 50, wherein the microfluidic channel has an average bore diameter of from about 20 μm to about 120 μm.

52. The method of claim 39, wherein the thick-film electrode has a thickness of from about 1 μm to about 100 μm.

53. The method of claim 52, wherein the thickness of the thick-film electrode is between about 8 μm and 30 μm.

54. The method of claim 39, wherein the distance between the thick-film electrode in fluidic connection with the outlet end of the microfluidic channel and the microfluidic channel is fixed.

55. The method of claim 54, wherein the distance between the thick-film electrode and the outlet end of the microfluidic channel is from about 1 μm to about 500 μm.

56. The method of claim 55, wherein the distance is between about 50 μm and about 100 μm.

57. The method of claim 39, wherein the thick-film electrode comprises a carbon ink electrode.

58. The method of claim 39, wherein the thick-film electrode comprises a metal conducting coating.

59. The method of claim 39, wherein the thick-film electrode comprises at least one member selected from the group consisting of metals, inorganic dopants, organic dopants, nucleic acids, catalytic surface modifiers, enzymatic surface modifiers, and permselective film coatings.

60. The method of claim 39, wherein the fluid solution comprises a buffer solution.

61. The method of claim 39, wherein the analyte comprises at least one member selected from the group consisting of nitroaromatic compounds, catecholamines, hydrazine compounds, phenolic compounds, enzyme-specific compounds, amino acids, nucleic acids, metal ions and anions.

62. The method of claim 61, wherein said nucleic acid is selected from the group consisting of DNA, scDNA, ssDNA, dsDNA, RNA and tRNA.

63. The method of claim 39, wherein the microfluidic channel further comprises separation media.